Q Meter CM1

Instruction Manual

MP MASTER
MA22715

Advance

Q Meter CM1

Instruction Manual

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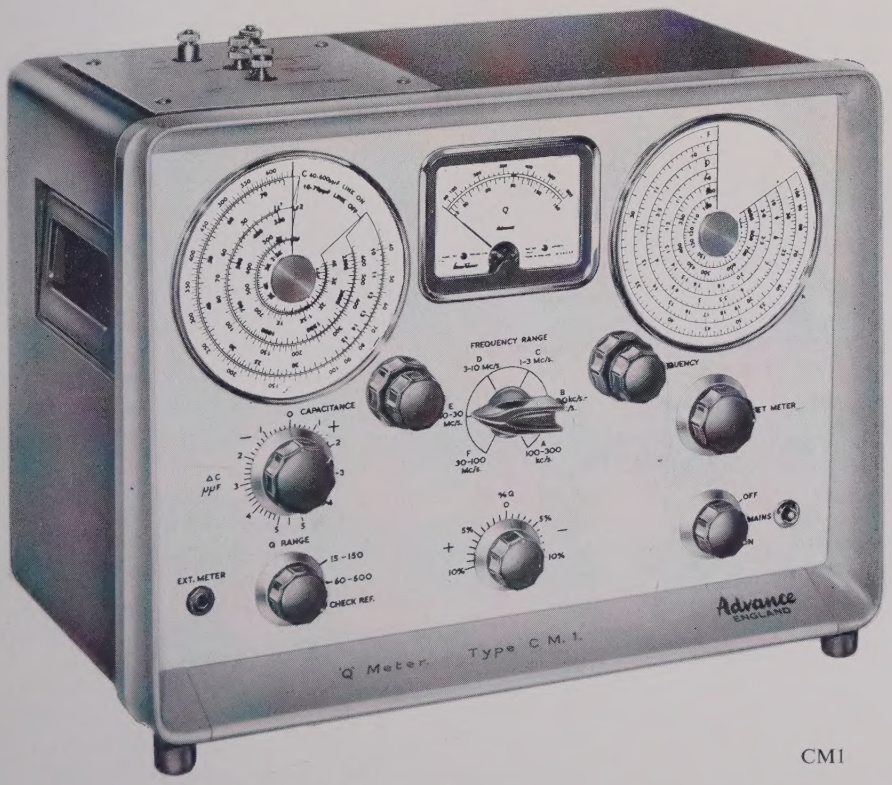
1 Introduction

The Advance Q meter type CM1 facilitates measurements of circuit magnification, inductance, reactance and capacitance in the frequency range 100kc/s to 100Mc/s. An Advance Volstat (constant voltage transformer) is incorporated to minimise errors caused by supply voltage variations, while the r.f. output level is stabilised over the frequency range, to eliminate the necessity for level adjustments prior to measurements. These features ensure stability of operation over long periods, enabling the instrument to be used for the batch testing of components.

High frequency measurements are made possible by the low capacity range of 10$\mu\mu$F to 70$\mu\mu$F. A 'Delta C' control having a range of $\pm$5$\mu\mu$F, in 0·2$\mu\mu$F divisions, is associated with the main capacitor range 40$\mu\mu$F to 600$\mu\mu$F, to facilitate interpolation and simplify comparison measurements. The capacity tuning dial incorporates scales calibrated in C, Lf^2 and Xf, for the ready calculation of capacitance, inductance and reactance. Both the main capacity and frequency controls can be locked for the purposes of comparison measurements. A '%Q' control permits Q deviations of $\pm$10% from the nominal to be readily measured.

High quality components and construction are used throughout the instrument, and the facilities provided ensure flexibility and ease of operation. The front panel is supported by a cast aluminium frame, with a two-tone grey finish. The test terminals, located at the top of the instrument, are rhodium plated for wear resistance and good electrical performance.



CM1

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2 Specification

Oscillator Frequency 100kc/s to 100Mc/s in six ranges:

100kc/s – 300kc/s
300kc/s – 1Mc/s
1Mc/s – 3Mc/s
3Mc/s – 10Mc/s
10Mc/s – 30Mc/s
30Mc/s – 100Mc/s

Accuracy: ±1%.

Capacitor Ranges Main scales:
10 – 70μμF (±1μμF)
40 – 600μμF (±2%)

Incremental Capacitance On 40 – 600μμF main capacitor range: ±5μμF, calibrated in 0·2μμF divisions.

Reactance Scales $Xf = \frac{1}{2\pi C.\,10^6}$

Two scales: 16,000 to 2,200 ohm – Mc/s
4,000 to 300 ohm – Mc/s

Inductance Scales $Lf^2 = \frac{1}{4\pi^2 C.\,10^6}$

Two scales: 2,400 to 400μH – Mc/s²
600 to 50μH – Mc/s²

Accuracy of inductance measurement: ±5% + residual inductance of 0·035μH.

Q Ranges 15 to 150; 60 to 600.
Accuracy: ±(5% + 5% F.S.D.) below 50Mc/s.
For Q values above 400 and frequencies above 50Mc/s, these tolerances may be doubled.

%Q Comparison Scale Range ±10% relative to the nominal Q reading, which can be adjusted to a convenient indication by the SET METER control.

External Meter A socket is provided to permit the use of an external Q indicating meter, which should have an F.S.D. of 100μA.

Power Supply Input voltages 105 to 125V, 195 to 225V, 225 to 260V, 50c/s only unless specified otherwise.

Dimensions Width 18 in., height 14in., depth 9·5in. (46 × 36·5 × 24cm).

Weight 38lb (17kg).

Accessories
Stand-Off Platform PN. 1157?

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3 Circuit Description

3.1 General

The circuit diagram for the CM1 is given in *fig.2*. The instrument comprises basically a six-range variable-frequency oscillator which feeds r.f. to the component measuring circuit, and via detectors, to the stabilising amplifier and voltmeter circuit. The measuring circuit is formed by a variable capacitor, which is tuned for resonance with the component under test. The voltage developed across the capacitor is detected and applied to a voltmeter, calibrated to give a direct reading of Q. The oscillator is modulated at the supply frequency to allow a.c. amplification of the detected signals, thus avoiding the necessity for zeroing adjustments during operation.

To maintain the oscillator output at a constant level over the entire frequency range, the r.f. input to the measuring circuit is detected and compared with a stabilised reference voltage. The error signal so produced is fed via an amplifier circuit to provide the h.t. and modulation for the oscillator.

3.2 Power supply

The power supply components are mounted on a tray chassis at the rear of the instrument. The a.c. input is routed via the voltage selector switch S2 and one pole (S1a) of the ON/SWITCH switch to the primary of T1, an Advance Volstat (constant voltage transformer). A neon lamp N1 is connected across the primary to provide an indication when the equipment is switched on.

The Volstat provides a.c. outputs of 300V for the h.t. supply, approximately 5V to develop the reference supply and three heater supplies of 6·3V. All the outputs are stabilised for a.c. input variations of $\pm 15\%$. C12 forms an integral part of the Volstat circuit.

The 300V output is full-wave rectified by bridge circuit MR1 and smoothed by C13, R1 and C14. ON/OFF switch S1b discharges the reservoir capacitor via R40 when the equipment is switched off. The heater supply for the input valves in the stabiliser and the voltmeter amplifier circuits is balanced about earth by RV45, while the heater supply for the output valve of the stabiliser amplifier is isolated from earth. The remaining heater supplies are referenced to earth.

3.3 R.F. Oscillator

V1 is connected in a modified Hartley oscillator circuit, with the range of six coils connected between grid and cathode via the FREQUENCY RANGE switch S3. Variable capacitor C4 is the main tuning control, with its trimmer C5, while C6 to C11 are trimmers for each individual range. The coil circuits not selected are shorted to earth via S3a, S3b and S3c.

The h.t. supply for V1 is derived via the stabiliser amplifier circuit, and comprises a d.c. and an a.c. voltage to anode modulate the oscillator to a depth of approximately 50%. The r.f. output of the oscillator is maintained at a constant level over the entire frequency range by detecting the modulation, comparing it with the reference signal, and using the error signal to develop the oscillator h.t. This system obviates the necessity for level setting adjustments during operation.

The oscillator output is inductively coupled and applied to the measuring circuit via wafer S3c of the FREQUENCY RANGE switch.

3.4 Stabilising circuit

The modulated r.f. output from the oscillator is detected by W2 and the resulting 50c/s is applied to the stabilising amplifier at the grid of V2. A reference voltage derived from the constant voltage transformer T1 is applied to the cathode of V2. The resulting a.c. difference or error signal between the grid and cathode is amplified by V2 and V3.

The anode output from V3 is a.c. coupled to the grid of V4 via C20, and is also detected by W3 and W4 to provide d.c. bias. Both a.c. and d.c. inputs are proportional to the reference voltage plus or minus the error signal. V4 is connected in a cathode follower circuit feeding the stabilised h.t. to the oscillator valve via the r.f. filter circuit C1, L7, C2.

3.5 Measuring circuit

The output from the r.f. oscillator is applied to an inductive loop. Part of the loop is a bar, from which terminals feed a constant proportion of the voltage to the resonant circuit, formed by the component under test and the tuning capacitor C26 and/or C27, C28. The two main variable capacitors, C26 and C27, are ganged together to form the CAPACITANCE adjustment control. With the terminal connecting link fitted, C26, C27 and C28 are included in circuit, C28 providing a fine adjustment of $\pm 5\mu\mu$F within the total range provided by the three capacitors of 40 to 600$\mu\mu$F. The detector V5 is permanently connected across C26 via C29.

The component under test is tuned to resonance by the variable capacitor circuit, the voltage across the capacitor(s) then representing the product of Q and the modu-

lated r.f. input signal. This voltage is detected by V5, and the output at the supply frequency is applied to the voltmeter amplifier circuit via the Q RANGE switch S4. The modulated r.f. voltage injected into the inductive loop is detected by silicon diode W2, part of the output being applied via potentiometer network R19, RV21 and R22 to the CHECK REF. position of the Q RANGE switch.

3.6 Voltmeter amplifier

Two signals are applied to the Q RANGE switch (S4): one from V5, the capacitor voltage detector, and one from W2, which detects the r.f. voltage injected into the loop L9. In the first position of S4 the detected capacitor voltage is fed via S4b, C30 and R28 to the grid of V6, the Q range covered being 15 to 150. In the second position of S4, the signal input voltage is attenuated to 25% of its detected value by network R24, R25 and R26, to increase the Q range by a factor of 4, i.e. 60 to 600. In the third position of S4, the detected r.f. voltage from W2 is routed to the amplifier, to enable its amplitude to be checked. Wafer S4a earths the unselected signal input, to minimise undesirable pick-up.

Valves V6 and V7 are connected in an a.c. coupled amplifier circuit, with the screen grid supplies stabilised by N2 and N3. The amplifier output is applied via C33 to the meter bridge circuit, W5 to W8, with feedback applied to V6 cathode from the bridge via R31 to R34. Variable resistors RV33 and RV32 in the feedback circuit, provide control of the feedback level and form the SET METER and %Q controls respectively. Preset resistor RV31 enables the range of control of RV32 to be adjusted.

The 100μA meter is connected across the bridge via series resistor R39 and the closed contacts of the external meter jack J1. R39 simulates the load imposed by an external meter; when an external meter is connected R39 is isolated and both internal and external meters provide an indication of Q.

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4 Operating Instructions

4.1 Preparation for use

Remove the rectangular plate that covers the a.c. supply socket at the rear of the instrument, and ensure that the voltage adjustment panel is correctly set for the local a.c supply.

The instrument incorporates a constant voltage transformer, which gives stable outputs for wide fluctuations of input voltage. In the standard model the transformer is designed to work from 50c/s supplies only. The CM1 will not work satisfactorily at other frequencies unless a different supply frequency was specified when ordering the instrument.

4.2 Controls

The function and general method of use for each of the controls is given in the following paragraphs:

Frequency Selection Measurements can be made at any frequency from 100kc/s to 100Mc/s (±1%) by the use of the FREQUENCY RANGE switch and the calibrated FREQUENCY control. The FREQUENCY RANGE switch provides six bands, continuous adjustment within each band being provided by the slow motion drive of the FREQUENCY control. The ranges covered are:

100kc/s to 300kc/s
300kc/s to 1Mc/s
1Mc/s to 3Mc/s
3Mc/s to 10Mc/s
10Mc/s to 30Mc/s
30Mc/s to 100Mc/s

The FREQUENCY dial can be locked in any position by a concentric ring on the slow motion drive, thus preventing inadvertent adjustment during comparison measurements.

Capacitance Adjustment A main CAPACITANCE control and a 'Delta C' control are provided to enable the component under test to be tuned to resonance. The main control has two capacity ranges, 10 to 70μμF and 40 to 600μμF. The 10 to 70μμF variable capacitor is permanently connected to the test terminals HIGH and 'E', the range being changed to cover 40 to 600μμF by connecting the link supplied to the HIGH terminal. The 'Delta C' control, which covers ±5μμF, in 0·2μμF divisions, is connected in circuit only when the link is fitted, and can be used to interpolate between the scale divisions of the 40 to 600μμF range. This control can also be used for comparison measurements, in conjunction with the 'Delta Q' control.

Further scales calibrated in Lf^2 and Xf^2 are associated with each of the main capacitor scales, to assist in the calculation of the inductance and reactance of the test component. The 10 to 70μμF and 40 to 600μμF sets of scales are coloured black and red respectively.

The main CAPACITOR dial is operated by a slow motion drive, which can be locked to avoid inadvertent adjustments during comparison measurements.

Q Range Selection The Q RANGE switch enables Q values from 15 to 150 or 60 to 600 to be measured on the panel meter, which is calibrated to suit both ranges. A CHECK REF. position is included on the Q RANGE switch, to check the setting of the r.f. input level to the measuring circuit. An internal stabiliser maintains the r.f. level constant over the entire frequency range and, once set by the SET METER control, does not normally require re-adjustment during use. Indication of the setting level is given by a red marker on the meter scale.

Set Meter Control This control enables the gain of the voltmeter amplifier to be adjusted, and is correctly set for accurate Q measurements when the meter provides an indication on the red marker with the Q RANGE switch set to the CHECK REF. position, and the %Q control at zero. It may be adjusted when making comparison measurements, when the meter indication for the standard component is set to a convenient reading rather than the actual Q value. It is importance to reset when normal Q measurements are resumed. The control is fitted with a friction collar, to reduce the change of accidental movement.

%Q Control This is a linear control in the voltmeter amplifier circuit, enabling the sensitivity of the amplifier to be varied by ±10%. The control can be used to compare the Q of similar test components, as detailed under the heading 'INDUCTORS—Comparison measurements'.

External Meter A jack is provided for the connection of an external meter to the instrument. The external meter used must have a full-scale deflection of 100μA. The optimum resistance of the external meter is 470 ohms, although variations from this will only slightly affect the internal meter calibration.

4.3 Stand-off platform

The stand-off platform accessory is useful for keeping unscreened coils away from the instrument case, and for supporting the larger inductors. The platform adds approximately 0·05μH and 2μμF to measurements of inductance and capacitance respectively.

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4.4 Method of measurements

Measurements made with the CM1 are based on indications provided by the various scales with the test circuit in resonance. For all measurements it is essential to fit an inductor (either the test coil, or a standard for capacitance measurements) and to adjust the FREQUENCY and/or CAPACITANCE controls for a peak reading on the meter. This reading indicates that the inductor circuit is in resonance with the internal variable capacitor, the scales of the various controls then providing the parameters of the inductor circuit. Where the test coil has a variable inductance, this can be varied, if required, to obtain resonance. The measurements which can be made on various components are detailed in the following paragraphs. The instrument should be set up with the Q RANGE control set to the CHECK REF. position and the SET METER control adjusted, if necessary, to give a meter reading on the red marker.

4.5 Inductors

General The capacitance with which an inductor will tune at a given frequency, and the Q at that frequency can be found as follows:

(a) Set the %Q and the 'Delta C' controls to their zero positions.

(b) Set the frequency to the desired value by means of the FREQUENCY RANGE and FREQUENCY controls.

(c) Adjust the CAPACITOR control for a peak reading (resonance) on the meter, using the 'Delta C' control, if in circuit, for interpolation as required.

The required capacitance can be read from the red or black 'C' scale (depending on whether or not the connecting link is fitted). The Q can be read from the panel meter, with the Q RANGE switch set to give an 'on-scale' reading.

The frequency at which an inductor will resonate with a given capacitor can be found in a similar manner, the required capacity being set on the CAPACITANCE control and the FREQUENCY control adjusted for resonance.

Inductance and Reactance The inductance and reactance of an inductor can be determined by use of the Lf^2 and Xf scales. The Lf^2 scales are computed from the equation

$$Lf^2 = \frac{1}{4\pi^2 C.10^6}$$

and the reactance scales from the equation

$$Xf = \frac{1}{2\pi C.10^6}$$

C being the capacitance required for resonance at a frequency f.

Thus, the inductance (in μH) of a coil can be determined by dividing the Lf^2 scale reading by the square of the resonant frequency (in Mc/s^2), and the reactance (in ohms) can be determined by dividing the Xf scale reading by the resonant frequency (in Mc/s).

Certain 'errors' can be introduced in the calculations of inductance and reactance by the self capacitance of an inductor. The true or 'pure' inductance (L_t) of a coil having a self capacity C_s is given by the equation

$$L_t = \frac{1}{4\pi^2 f^2 (C + C_s)}$$

Hence, if the pure inductance of a coil is required, the value for the self capacitance must be found (see under separate heading) and added to the capacitance scale reading for resonance before a calculation from the Lf^2 and Xf scales is made. For example, if the self capacitance of a coil is found to be 7$\mu\mu$F, and the circuit resonates with an indicated capacity of 65$\mu\mu$F, then the Lf^2 and Xf scale readings corresponding to 65 + 7$\mu\mu$F (i.e. 72$\mu\mu$F) must be taken.

Q Value (true) The Q value of the test component is indicated on the panel meter. If the self capacitance of a coil is an appreciable fraction of the capacitance required for tuning to resonance, the Q value indicated on the meter will not be the actual Q of the pure inductance. The true Q of a coil (Q_t) is given by the equation

$$Q_t = Q_i \left(1 + \frac{C_s}{C}\right)$$

$$= Q_i + Q_i \frac{C_s}{C} \quad . \quad . \quad . \quad . \quad . \quad (1)$$

where Q_t = the true Q value, assuming no self capacity, at a given frequency

Q_i = the indicated Q value at the given frequency

C = the capacity required to tune the coil for resonance at the given frequency

C_s = the inherent self capacity of the coil.

From equation (1) the true Q of a coil can be readily calculated. For example, if at resonance the indicated Q is 90, the indicated capacitance is 100$\mu\mu$F and the self capacitance (see under separate heading) is known to be 10$\mu\mu$F, then the true Q has the value

$$90 + \frac{90 \times 10\mu\mu F}{100\mu\mu F} = 99.$$

Self Capacitance Using readings taken on the CM1, the self capacitance of a coil can be calculated from the equation

$$C_s = \frac{C_2 - C_1\left(\frac{f_1}{f_2}\right)^2}{\left(\frac{f_1}{f_2}\right)^2 - 1} \quad . \quad . \quad . \quad . \quad . \quad (2)$$

where C_1 is the capacity required to resonate the coil at a frequency f_1, and C_2 is the capacity required to resonate the coil at a frequency f_2.

If the frequency f_2 is selected such that $f_2 = \frac{f_1}{2}$, equation (2) becomes

$$C_s = \frac{C_2 - 4C_1}{3} \quad . \quad . \quad . \quad . \quad . \quad (3)$$

thus simplifying the calculations. The procedure using equation (3) is as follows:

(a) Set the CAPACITANCE control to a low value of capacity (C_1), say 50$\mu\mu$F, and adjust the FREQUENCY control for resonance. Note the frequency.

(b) Set the FREQUENCY control to half the value noted in **(a)**, resetting the FREQUENCY RANGE switch if necessary. Re-adjust the CAPACITANCE control for resonance, and note the capacity (C_2).

(c) Substitute the values for C_1 and C_2 in equation (3), and calculate the self capacity.

Where it is not possible or practicable to select the frequency f_2 equal to $\frac{f_1}{2}$, the same general procedure can be used, but the frequencies used in **(a)** and **(b)** should be noted (f_1 and f_2 respectively), and equation (2) adopted for the calculations.

Comparison Measurements Comparison measurements of a number of inductors (e.g. on a production run) can be made as follows:

(a) Set the 'Delta C' and %Q controls to their centre zero positions. Fit the standard coil to the test terminals, and tune for resonance. Note the Q reading (the SET METER control can be adjusted to give a convenient value, if desired). Lock the FREQUENCY control and, if on the 40–600$\mu\mu$F range, the CAPACITANCE control.

(b) Replace the standard inductor with a test inductor and adjust the 'Delta C' control for resonance. Adjust the %Q control to give the Q reading obtained for the standard coil. The difference in Q values between the test coil and the standard is indicated as a percentage on the %Q control.

Where it is necessary to use the 10 to 70$\mu\mu$F tuning capacitor range, the main CAPACITANCE control must be re-adjusted for resonance, since the 'Delta C' control is not then in circuit.

4.6 Capacitors

The capacitance of a capacitor in the range of the CAPACITANCE control can be obtained by the substitution method:

(a) Set the CAPACITANCE control to a high value of capacity, connect an inductor to the test terminals, and adjust the FREQUENCY control for resonance.

(b) Connect the test capacitor across the inductor and re-adjust the CAPACITANCE control for resonance. The difference between the two readings on the capacity scale is a direct measure of the capacitor under test.

If the capacitor to be measured is outside the range of the CAPACITANCE scale, the following procedure can be adopted:

(a) Connect an h.f. standard inductor across the test terminals, select a convenient value of frequency (f_1) and tune the CAPACITANCE control for resonance. Note the capacitance (C_1).

(b) Reset the FREQUENCY control to an exact sub-multiple of the frequency f_1 used in **(a)**; for example $\frac{f_1}{2}$, $\frac{f_1}{3}$ etc. This frequency is f_2. Connect the test capacitor across the inductor, and re-adjust the CAPACITANCE control for resonance. Note the capacity (C_2).

The value of the test capacitor can then be calculated from the equation

$$C_t = K^2C_1 - C_2 \quad . \quad . \quad . \quad . \quad (4)$$

where C_t = the value of the test capacitor

$K = f_1/f_2$

and C_1 and C_2 = the CAPACITANCE scale readings noted in **(a)** and **(b)** respectively.

If the self capacity of the standard inductor is of any appreciable magnitude, its value will have to be found and added to the values of C_1 and C_2 before the calculation from equation (4) can be made.

Q Measurements of Small Capacitors The Q values of small capacitors are generally too large to be read with any accuracy. Approximations may be made by resonating a coil on the Q meter, and then noting the reduction in Q obtained when the capacitor is added.

When the added capacitance is large in proportion to the Q meter minimum capacitance (10pF), the following formula will give the Q of the capacitor.

$$Q_c = \frac{Q_1 \quad Q_2}{Q_1 - Q_2} \quad . \quad . \quad . \quad . \quad . \quad . \quad (5)$$

Q_1 is the Q of the coil.
Q_2 is the Q of the coil plus added capacitance.

When the added capacitance is small in proportion to the Q meter minimum capacitance of 10pF, the above expression must be modified to allow for the sharing of the oscillatory current between the test capacitance and the Q meter capacitance. The general formula is

$$\frac{1}{Q_1} - \frac{1}{KQ_c} - \frac{1}{Q_2} \quad . \quad . \quad . \quad . \quad . \quad . \quad (6)$$

where K is the ratio of total capacity to the capacity of the test capacitor. If the Q meter capacitor is adjusted to the value of the test capacitor, i.e. $K = 2$ then the formula simplifies to,

$$Q_c = \frac{Q_1 \quad Q_2}{2\,(Q_1 - Q_2)} \quad . \quad . \quad . \quad . \quad . \quad (7)$$

4.7 Resistors

The resistance of a resistor at r.f. can be obtained as follows:

(a) Connect an inductor to the test terminals, and adjust the FREQUENCY and CAPACITANCE controls for resonance. Note the Q reading (Q_1), and the Xf scale reading.

(b) Connect the resistor across the inductor, and note the new Q reading (Q_2).

The resistance can then be calculated from the following equation

$$R = \frac{Q_1 \times Q_2}{Q_1 - Q_2} \times \frac{Xf}{f} \quad . \quad . \quad . \quad . \quad (8)$$

5 Maintenance

5.1 General

In order to maintain accurate Q readings, care must be taken to ensure that the insulation of the test terminals does not deteriorate due to dust, etc. It is, therefore, necessary to clean the insulators occasionally; access can be readily obtained by removing the chromium plated terminal plate.

To remove the instrument from its case:

(a) Remove the terminal screws and link, and remove the terminal plate held by mushroom-headed screws.
(b) Pull off the spring-loaded drive knobs from the FREQUENCY and CAPACITANCE controls.
(c) Carefully lay the instrument 'face' down, and remove the four retaining screws at the rear of the case.
(d) Free the bottom edge of the case from the front casting, using the feet as a grip. Then free the front edge by inserting a small bar between case and casting along one side, and 'rocking' the case back. When the case is free, lift carefully to clear the terminals.

The location of major components is indicated in *fig.1.*

5.2 Calibration adjustments

Set Meter Control The SET METER control can be aligned, if desired, so that its cursor is in line with the panel mark, when the control is correctly adjusted as detailed in the Operating Instructions. The procedure is:

(a) Pull off the spring-loaded knob, exposing its boss and retaining screw.
(b) Loosen the retaining screw, reset the boss and tighten the screw.
(c) Replace the knob.

Q Scales A check of the accuracy of the Q readings can be made if a standard coil of known Q is available; adjustments should not be made unless the accuracy of the standard is known. To make the check and adjustments:

(a) Connect the standard coil to the test terminals, and tune for resonance at the frequency at which the Q is known.
(b) Adjust the SET METER control to give the correct Q reading.
(c) Switch the Q RANGE control to the CHECK REF. position. Carefully insert a screwdriver through the EXTERNAL METER socket, and adjust the potentiometer positioned behind it to give a meter reading on the red calibration mark.

For the next two adjustments, the instrument should be removed from the case.

%Q Range The range of the %Q control can be adjusted by RV31, on the main printed circuit board, as follows:

(a) Switch the Q RANGE control to the CHECK REF. position, turn the 'Delta Q' control to −10%, and adjust the CALIBRATION control to give a reading of 270.
(b) Reset the %Q control to −10%, and note the meter reading (r). Adjust RV31 so that the reading becomes

$$\frac{60}{r - 270} \times 330$$

(i.e. if the reading is 330, no adjustment is required).

Note that adjustment of RV31 affects the Q indication with the %Q control in the −10% position; however, when set as described above, the meter should give a ±10% swing in indication when the %Q control is set from the −10% to +10% positions.

Oscillator H.T. The maximum h.t. voltage to the r.f. oscillator is obtained at 100kc/s, and is approximately 130V. The voltage is adjusted by RV15, which sets the level of the internal reference supply: no adjustment should be attempted, however, unless there is definite evidence of faulty operation (e.g. wide variations of the CHECK REF. indication over the frequency range). The h.t. voltage should be between 130V and 60V, depending on the frequency; if, after resetting for approximately 130V at 100kc/s, the h.t. rises above the 100kc/s voltage level or below 50V at any frequency, the oscillator section must be suspected of being faulty.

The circuits used in the CM1 are not critically dependent on valves, and should operate with wide variations of valve characteristics.

Where difficulties of maintenance are experienced, the instrument should be returned to Advance Electronics Ltd. for servicing.

6

6 Schedule of Components & Circuit Diagram CM1

Resistors

Ref.	Description			Part No.
R1	8·2K	10%	Erie 8	9146
R2	15K	10%	Dubilier BTT	1130
R3	1M	10%	Dubilier BTT	406
R4	22	10%	Erie 9	4419
R5	3·3K	10%	Dubilier BTT	7116
R6	Selected on test			
R7	Selected on test			
R8	180K	10%	Dubilier BTT	1125
R9	2·2M	10%	Dubilier BTT	1120
R10	680K	10%	Dubilier BTT	1122
R11	150K	10%	Dubilier BTT	1126
R12	330	10%	Dubilier BTT	10986
R13	2·2M	10%	Dubilier BTT	1120
R14	10M	10%	RMA 9	1179
RV15	100K potentiometer		MPD	2383
R16	33K		RRC 5SWD33	1242
R17	470		RRC 5SWD33	2059
R18	~~Not used~~ 22M	10%	RRC type S	3996
R19	12K	10%	Dubilier BTT	10738
R20	15K	10%	Dubilier BTT	1130
RV21	5K variable		Colvern CLR901	7700
R22	2·7K		Dubilier BTT	10990
R23	~~45M~~ 22M	~~5%~~ 10%	RRC type S	~~1415~~ 3996
R24	1·5M		Welwyn C22	10030
R25	4·5M		Welwyn C21	10029
R26	1·5M		Welwyn C22	10030
R27	220K		Dubilier BTT	1123
R28	10M		RRC 2HS2	12327
R29	397		Welwyn HSC22	10330
R30	100K		Dubilier BTT	10627
RV31	1K variable		Egen 195	915
RV32	1K variable		Colvern CLR4207/20S	916
RV33	1K variable		Colvern CLR4207/20S	916
R34	484	1%	Welwyn C22	10331
R35	180K		Dubilier BTT	1125
R36	1M	10%	Dubilier BTT	406
R37	220	10%	Dubilier BTT	10731
R38	47K	10%	Dubilier BTT	1128
R39	470	10%	Erie 9	1671
R40	10K	10% 1W	Erie 8	1825
R41	Not used			
R42	22 nominal (selected on test)		Dubilier BTT	
R43	397	1%	Welwyn HSC22	10333
R44	56	10%	Dubilier BTT	11351
RV45	100 variable		Egen 195	
R46	100K	10%		10627
R47	120		Dubilier BTT	10736

Capacitors

C1	0·005μF		400V	Hunts W99	8780
C2	0·005μF		400V	Hunts W99	8780
C3	560μμF	20%		Erie K1200	329
C4	13–528μμF			Plessey 9371/3A	7368A
C5	Wire trimmer				7810
C6	Wire trimmer				7810
C7	Wire trimmer				7810
C8	Wire trimmer				7810
C9	Wire trimmer				7810
C10	Wire trimmer				7810
C11	Wire trimmer				7810
C12	2·5μF (selected with transformer)				13087
C13	100μF		350V	P.C.Plessey CE 682/17	913
C14	+200μF				

Capacitors (cont.)

Ref.	Description				Part No.
C15	16μF		350V	P.C. Plessey CR 6003	11863
C16	16μF				
C17	100μμF	5%		Lemco 1106R Insul.	2758
C18	0·1μF	20%	350V	Plessey Plesseal	11860
C19	200μF		6V	Plessey CE206	12972
C20	0·005μF	20%	400V	Hunts W99	8780
C21	0·1μF	20%	350V	Plessey Plesseal	11860
C22	0·1μF	20%	350V	Plessey Plesseal	11860
C23	Not used				
C24	0·04μF	~~20%~~	~~150V~~	~~Hunts W99~~	~~7485~~
C25	750–1,500μμF			Feedthrough cap. Lemco 310K	919
C26	4–70μμF			Ganged W.R.Type C1002/	
C27	30–550μμF			42FS24/012RS3/012	14289
C28	3–25μμF			W.R.Type C8–04	5998
C29	47μμF	20%		Erie Style AN/750	12058
C30	0·04μF		150V	Hunts W99	7485
C31	0·05μF	20%	500V	Plessey Plesseal	11489
C32	200μF		6V	Plessey CE206	12972
C33	0·025μF	20%	500V	Plessey Plesseal	1448
C34	0·01μF	20%	400V	Hunts W99	7568
C35	0·005μF	20%	400V	Hunts W99	8780
C36	3,300μμF	20%	400V	TCC/CTH 315	496
C37	100μμF	5%		Lemco 1106R	2758
C38	0·005μF	20%	400V	Hunts W99	8780

Miscellaneous

L1	Osc. coil and coupling	30–100Mc/s	7421–7423
L2	Osc. coil and coupling	10–30Mc/s	RF589
L3	Osc. coil and coupling	3–10Mc/s	RF536
L4	Osc. coil and coupling	1–3Mc/s	RF537
L5	Osc. coil and coupling	300–1000kc/s	RF593
L6	Osc. coil and coupling	100–300kc/s	RF592
L7	HT choke		C16
L8	HT choke		C95
L9	Inductive loop to test circuit		
V1	ECC91 (6J6)	(Oscillator)	7034
V2	6AM6	(Stabiliser Amplifier)	7312
V3	6AM6	(Stabiliser Amplifier)	7312
V4	6CH6	(Series Regulator)	9065
V5	EA52	(Voltmeter Diode)	911
V6	6AM6	(Stabiliser Amplifier)	7312
V7	6AM6	(Stabiliser Amplifier)	7312
W1	Not used		
W2	CS2A Silicon diode		7110
W3	5E4		
W4	5E4 Voltage doubler		489
W5–W8	OA70		342
MR1	Rectifier B300 c70 S & H		918
S1	Supply switch, 2-pole 2-way Bulgin 5467		908
S2	Voltage selector, Bulgin		A14580
S3	Frequency range switch, Walters W2110		7381
S4	Switch, Trolex A.B. Metal		14721
T1	Supply transformer Volstat		CV25/32
J1	External meter jack Igranic Type P72		10805
P1	External meter plug Igranic Type P50		10806
N1	Neon indicator 125V		1165
N2	Neon stabiliser, Type Hivac 3L (60V)		12781
N3	Neon stabiliser, Type Hivac 3L (60V)		12781
M1	0–100μA meter		A14288
FS1	Fuse 1A, Belling Lee 1055/1		4732
TH1	Thermistor STC A14		7811
	Instruction Manual		1356

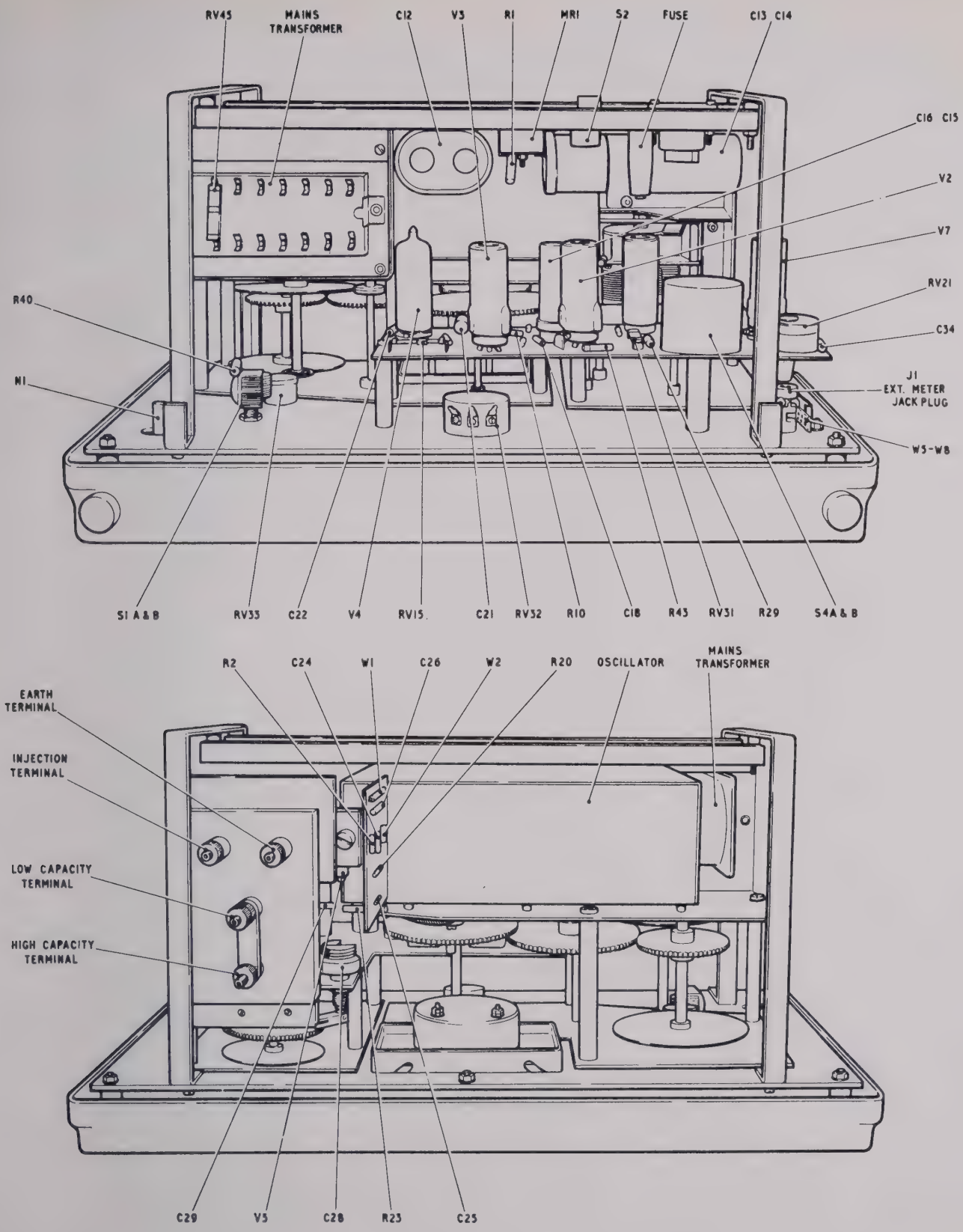
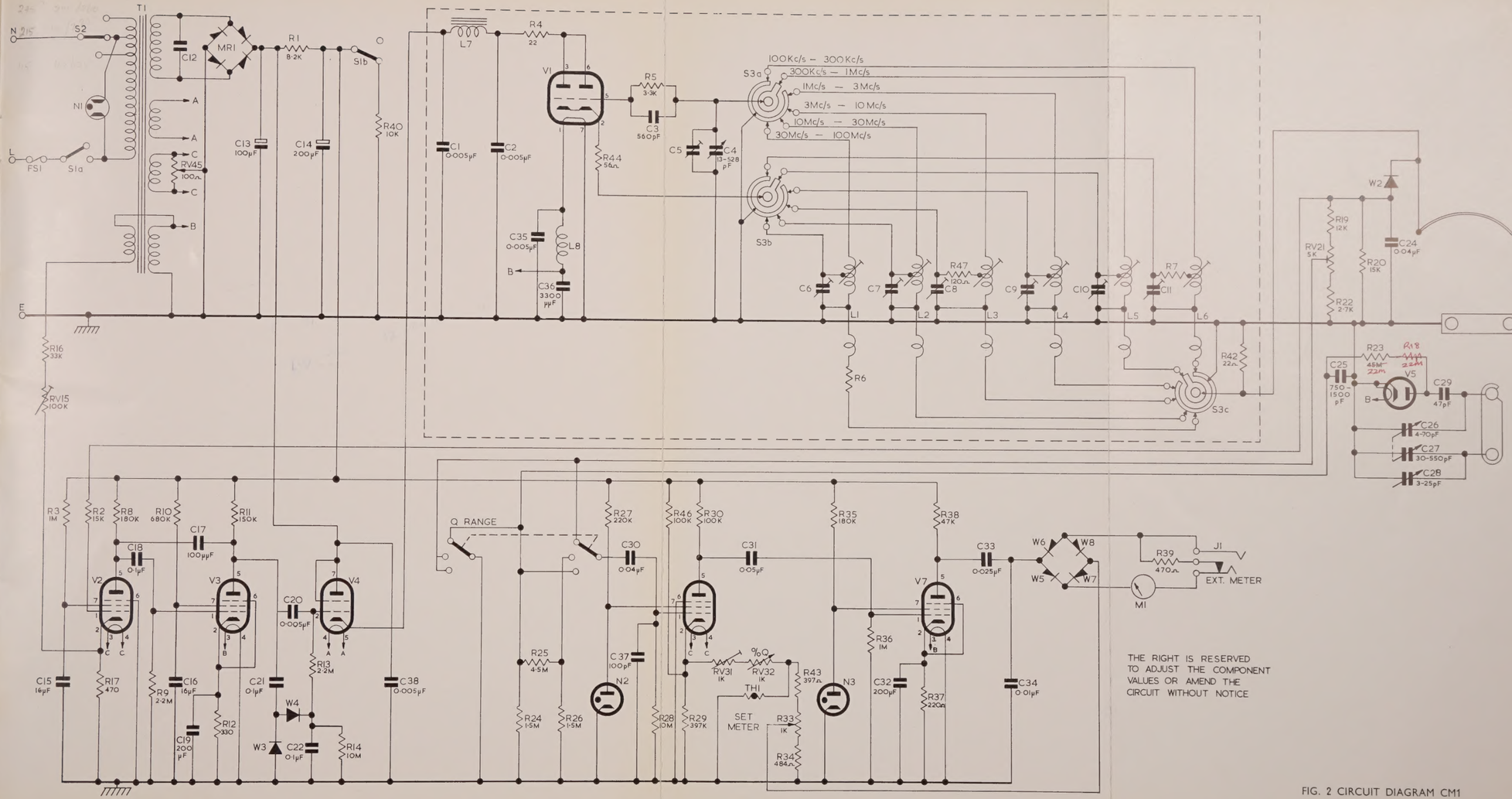


FIG.1- COMPONENT LOCATION DIAGRAM



DRAWING CSK 1428, ISSUE 2

THE RIGHT IS RESERVED TO ADJUST THE COMPONENT VALUES OR AMEND THE CIRCUIT WITHOUT NOTICE

FIG. 2 CIRCUIT DIAGRAM CM1